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GB 2200964 A US 4068865 A

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(54) A connector adapted for use undersea

(57) Connector (10) comprises a ring of locking members (36) in supporting structure (14), members (36) being radially movable inwards for locking and outwards for unlocking connector (10). Two ring-form cams (48, 50) co-axial with the ring of members (36) are rotatable about its axis. Four hydraulic piston units (76) connected between supporting structure (14) and cams (48, 50) rotate cams (48, 50) in one direction or the other for positively moving members (36) radially inwards and outwards for locking and unlocking connector (10).

Locking members (36) have stems (38) which extend through radial passages (46) in main body (14) and cam followers (42), engageable with cams (48, 50), at their outer ends.

Units (76) provide a larger effective piston area for unlocking than for locking, giving greater torque for unlocking than for locking, and are connected by removable pivots (82, 88) permitting removal and replacement of units (76).

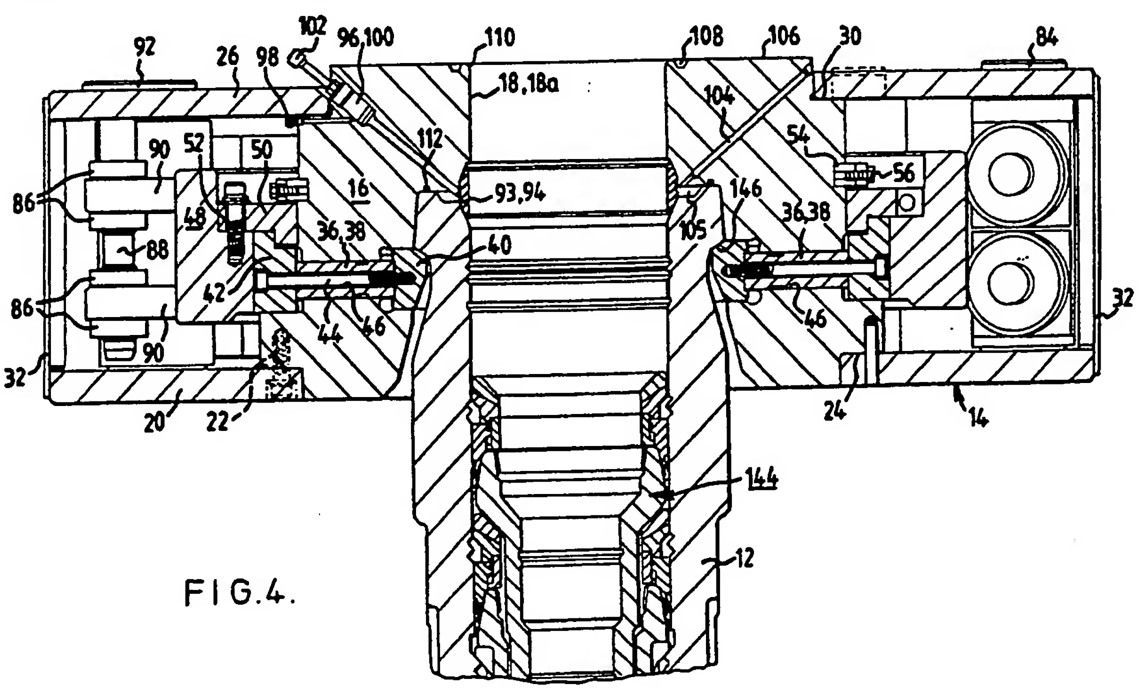

FIG.4.

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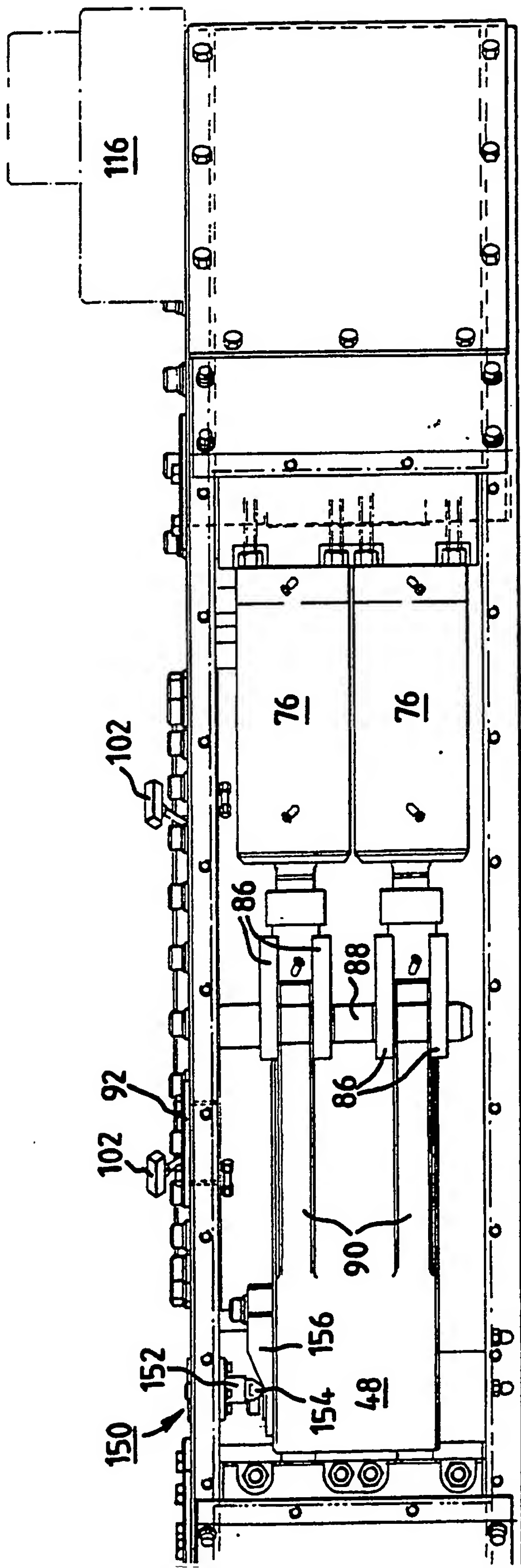


FIG.1.

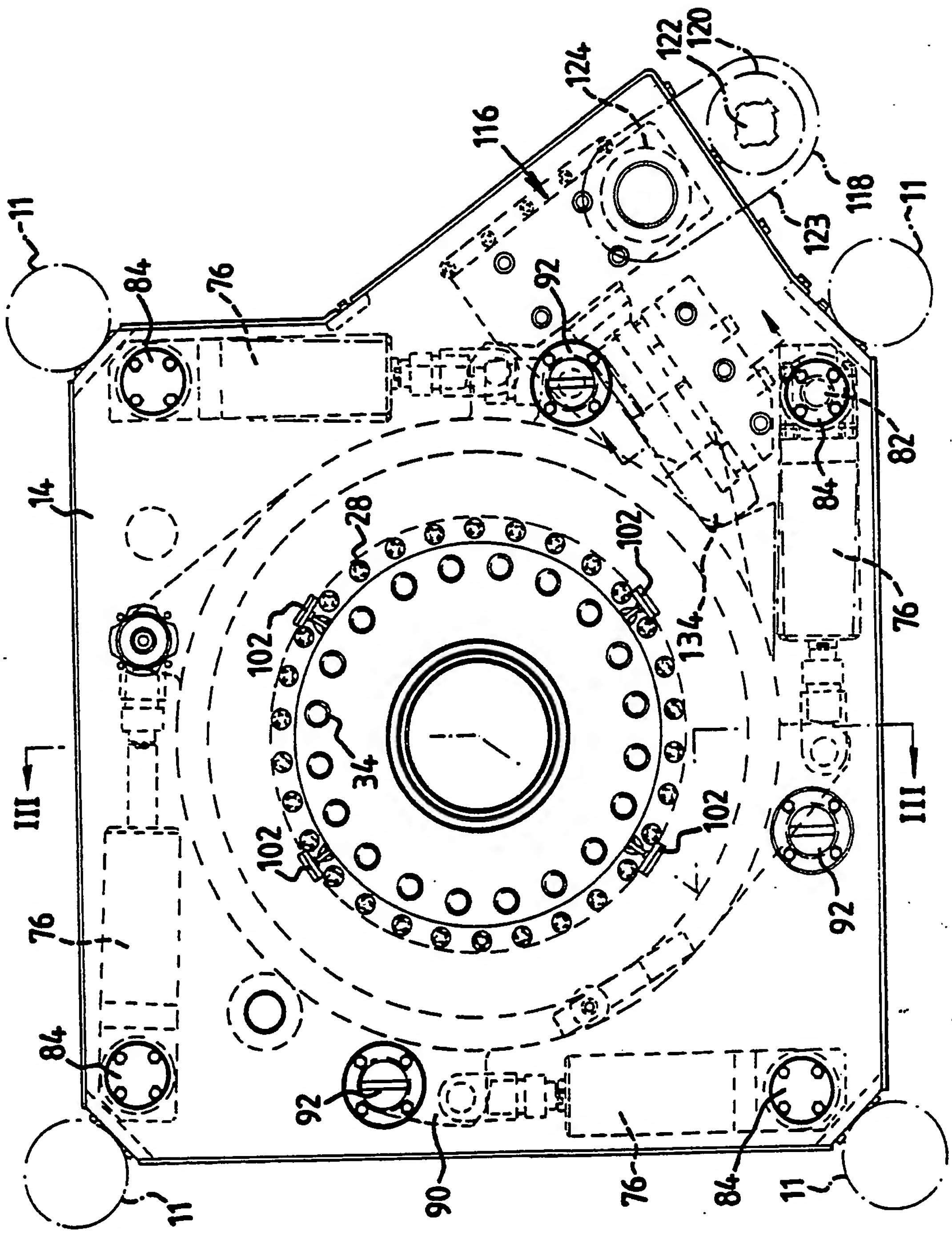
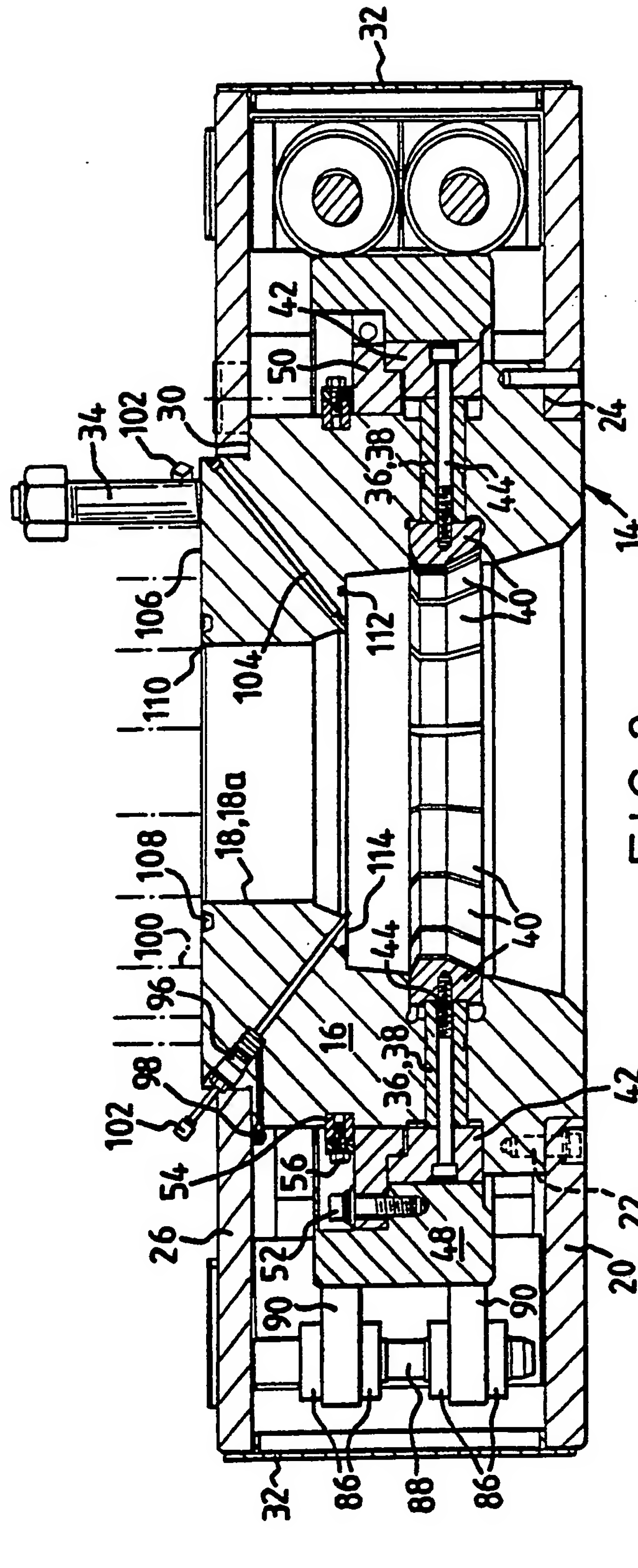


FIG.2.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100
96
44
40
16
98
102
36,38
42
54
56
22
26
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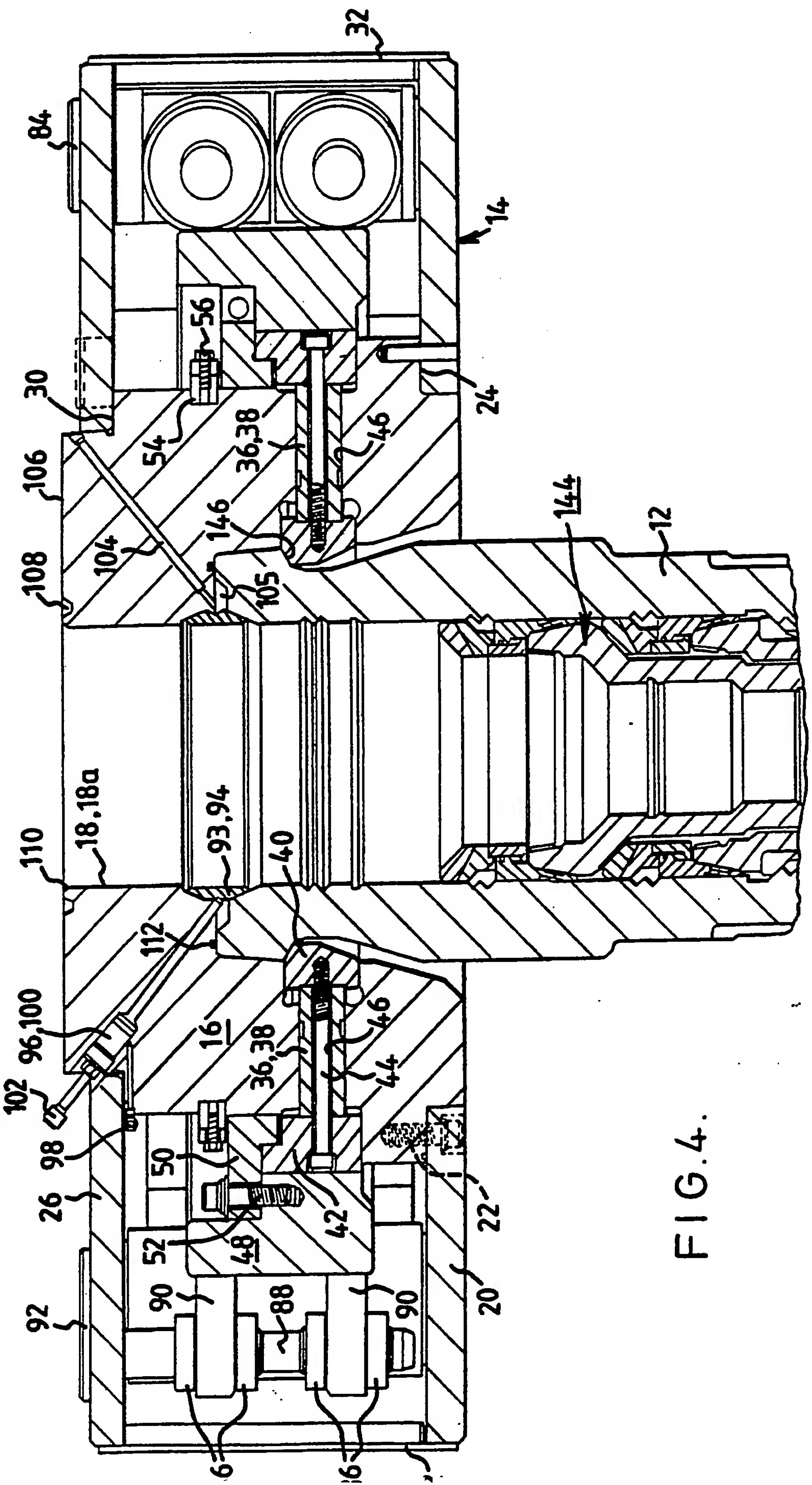
90
90
32
86
88
86

FIG.3.



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84
14
56
30
24
106
54
36,38
46
146
104
144
12
108
105
18,18a
110
93,94
40
112
96,100
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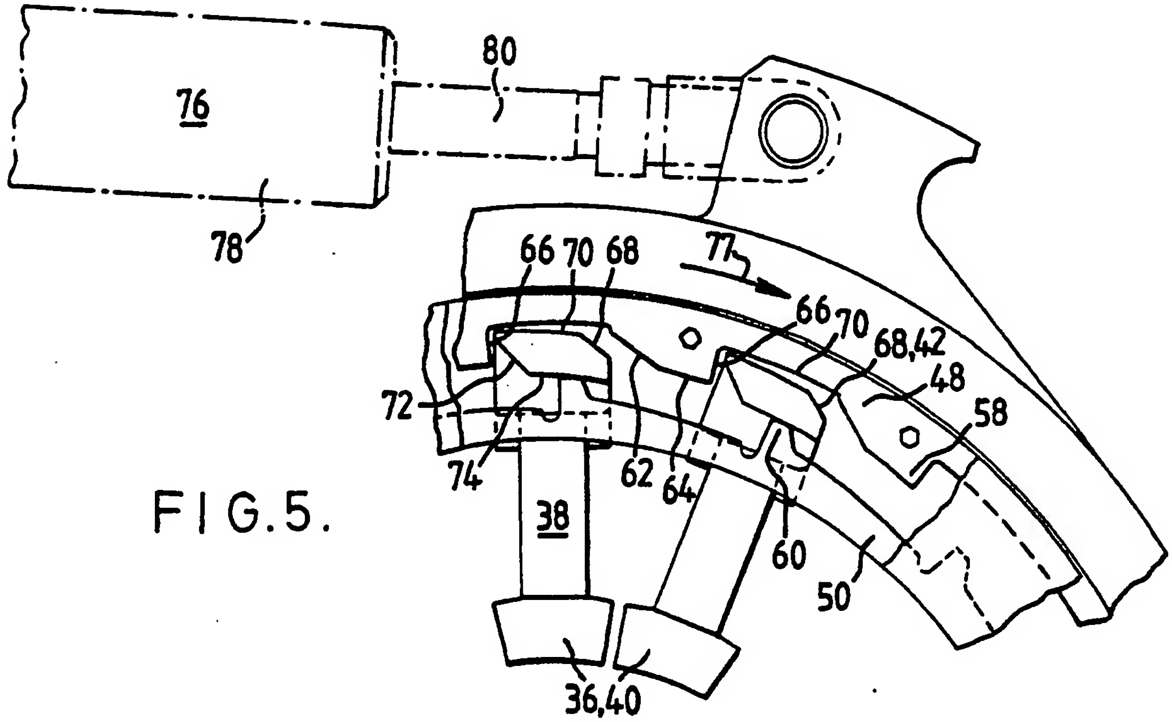
20

FIG.4.


76
80
78
66 70 68
77
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68,42
48
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72
74
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38
50
36,40

FIG.5.

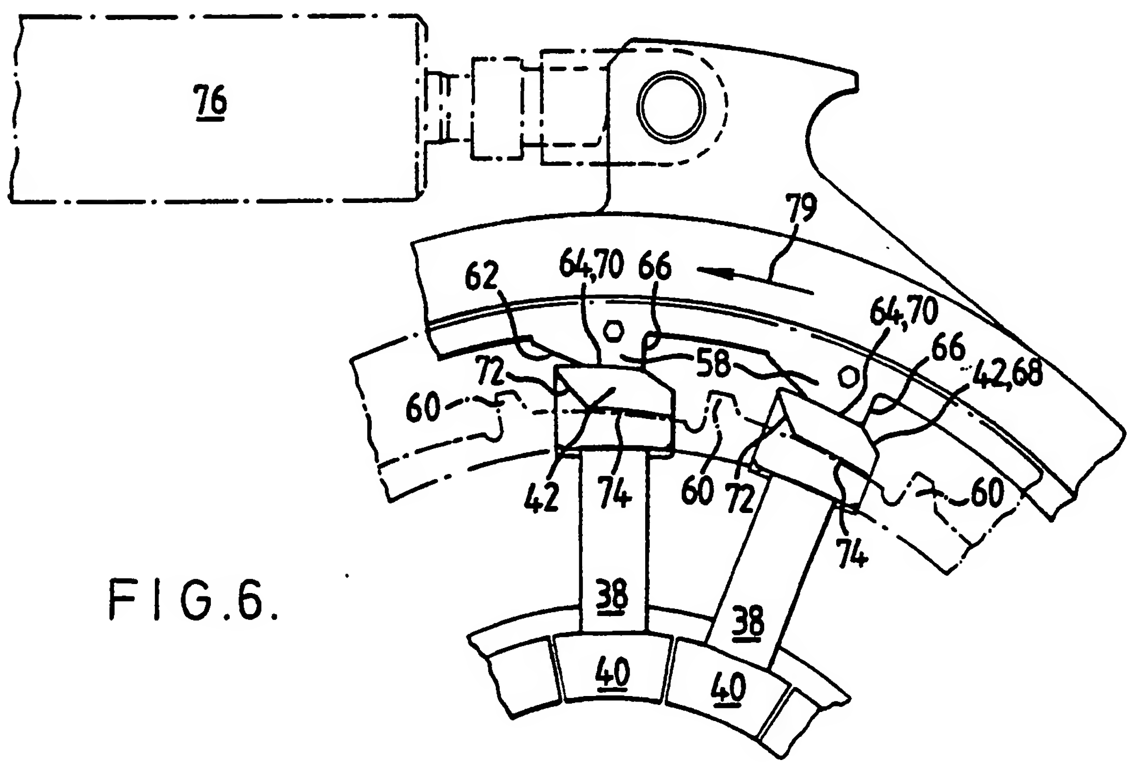
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FIG.6.

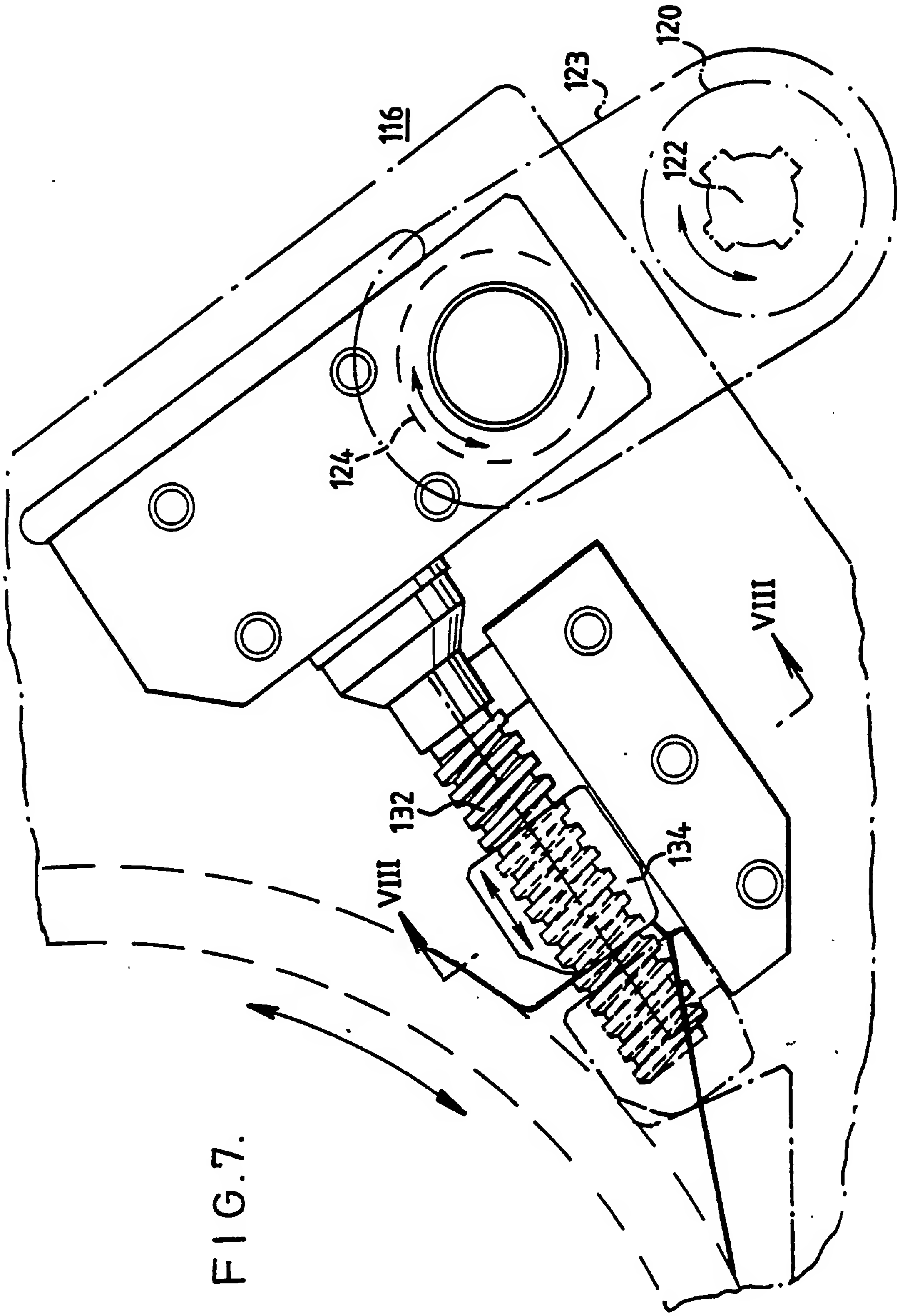
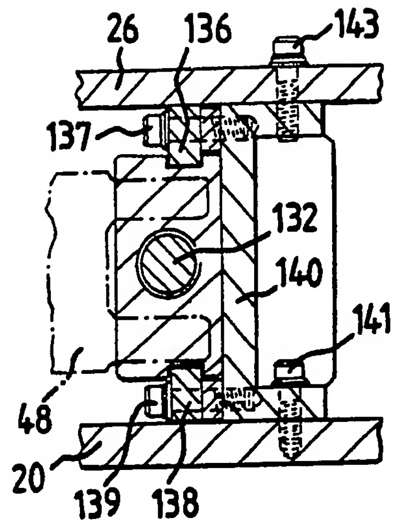


FIG.7.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136
143
137
132
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141
48
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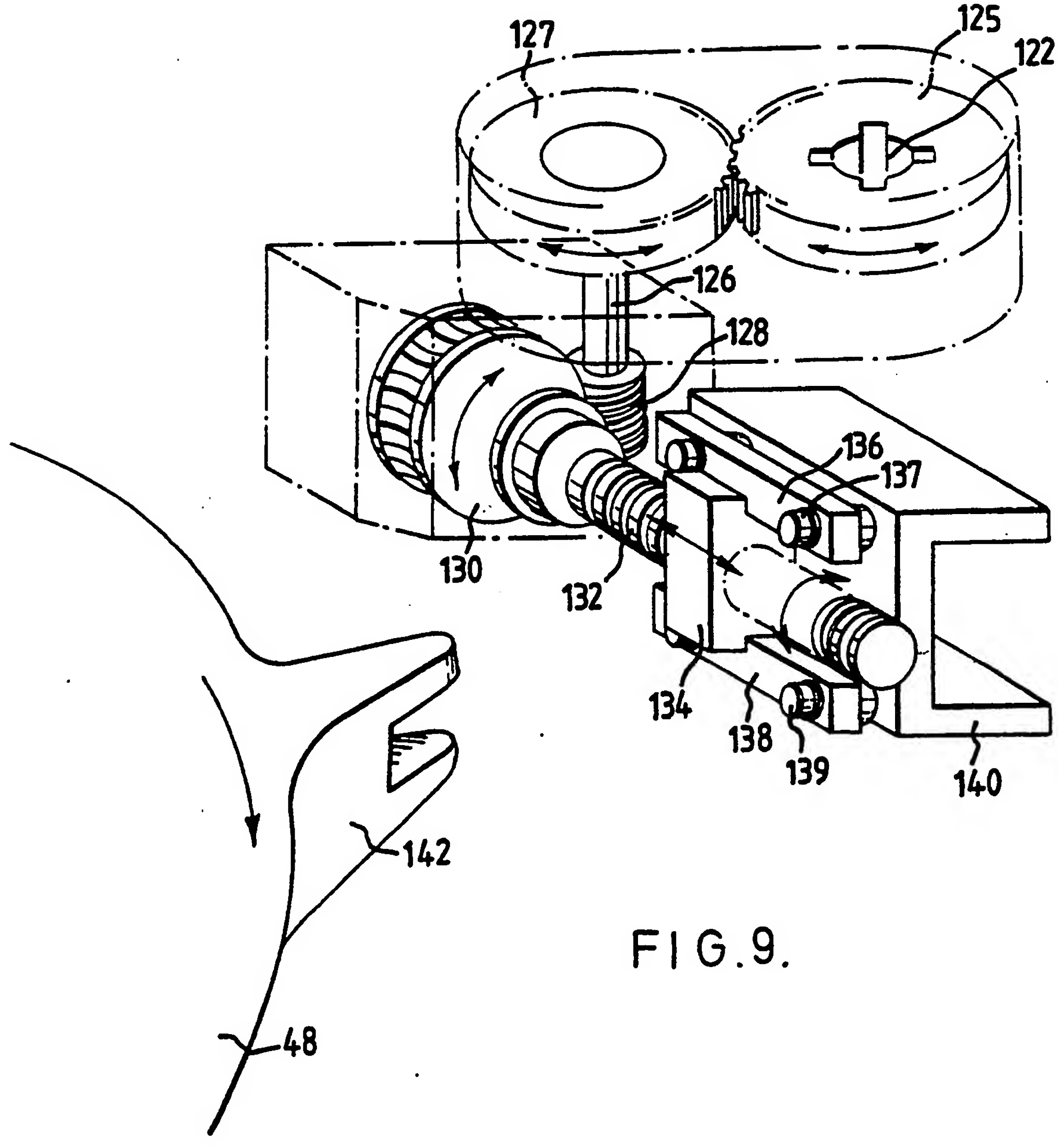
139
138

FIG.8.


127
125
122
126
128
136
137
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132
134
138
139
140
142
48

FIG.9.

A CONNECTOR ADAPTED FOR USE UNDERSEA

This invention relates to a connector adapted for use undersea. Possible uses for the connector in the oil industry may include connection of a blow-out preventer ("BOP") stack to a wellhead body, or connection of a sub-sea "Christmas Tree", or use as a flow-line connector.

A connector for use undersea in the oil industry is required to withstand enormous forces and pressures in service. It is also required to be able to be operated or serviced in a hostile environment - undersea at great depths - and, in an emergency, to remain operational until the emergency is under control. The connector must be capable of removal when required, even under extreme adverse conditions.

The present invention provides a connector adapted for use undersea as claimed in each of the claims, to which reference is directed.

The invention will be described by way of example with reference to the drawings, wherein:-

FIG. 1 is a side elevation of a connector embodying

the invention;

FIG. 2 is a plan view of the connector of Fig. 1;

FIG. 3 is a section on III-III of Fig. 2;

FIG. 4 corresponds to Fig. 3, but showing the connector fitted to a wellhead body;

FIGS. 5 and 6 are partial views of the ring of locking members, two ring-form cams and one piston-in--cylinder unit, in two different positions, namely, unlocked and locked, respectively;

FIG. 7 is a partial view of a mechanical over-ride mechanism for unlocking the connector;

FIG. 8 is a section on VIII-VIII of Fig. 7; and

FIG. 9 is an exploded perspective view of the mechanical over-ride mechanism showing a minor modification.

The connector 10 shown in the drawings is adapted for use undersea in the oil industry. In the particular form shown, it is adapted for connecting a blow-out

preventer or "BOP" stack (not shown, except for vertical guide sleeves 11 in Fig. 2) to a wellhead body 12 (Fig. 4).

Body Structure 14

The connector 10 comprises a body structure 14 which serves as a supporting structure for various moving parts, as described hereinafter. The body structure 14 will be described now in general terms.

The body structure 14 comprises a unitary main body 16 of substantial thickness, to withstand enormous forces and pressures of oil through the wellhead body 12. The main body 16 has a vertical central bore 18 of 18.75 inches (476.25 mm) minimum diameter for the through-flow of the oil. As shown, the narrowest part 18a of the bore 18 is at the top of the main body 16, the bore 18 widening downwardly progressively.

A base plate 20, which is 3 inches (76.2 mm) thick, fits tightly around the bottom of the main body 16, to help the latter withstand the enormous pressures, and is bolted thereto by a lower ring of vertical bolts 22, the base plate 20 bearing against an annular ledge 24 around the bottom of the main body 16.

A top plate 26, which is 2 inches (50.8 mm) thick,

is similarly fitted tightly around the top of the main body 16 and is bolted thereto by an upper, outer ring of vertical bolts 28 (Fig. 2), the top plate 26 bearing against an annular ledge 30 around the top of the main body 16. Outer cover plates 32 (partly removed to show internal construction of the connector 10) are bolted as shown to the outsides of the base and top plates 20, 24 to extend between them.

An upper, inner ring of vertical bolts 34 (Figs. 2, 3) secures the connector 10 to the BOP stack, not shown except for the vertical guide sleeves 11. The guide sleeves 11 of the BOP stack fit closely around the connector 10, as shown in Fig. 2.

Ring of Locking Members 36

The connector 10 comprises a ring of locking members 36. Each locking member 36 comprises a radial stem 38, a radially inner head 40 and a radially outer cam-follower part 42, all bolted together by a radial bolt 44. The stem 38 and bolt 44 extend slidably through a respective one of a ring of radial passages 46 through the main body 16.

Ring-form cams 48, 50

The connector 10 comprises a ring-form cam 48 for positively moving the locking members 36 radially

inwards and a second ring-form cam 50 for positively moving the locking members 36 radially outwards. The two ring-form cams 48, 50 are secured together by a ring of bolts 52 to form a unitary structure which is rotatable about the combined axis of the cams 48, 50, this axis being coincident with the axis of the bore 18. The cam 50 fits inside the cam 48 as shown. A retainer ring 54 is secured by radial bolts 56 in a groove (unreferenced) around the outside of the main body 16 above the top of the cam 50, to retain the cams 48, 50 in position.

The outer cam 48 has inwardly projecting teeth 58, (Figs. 5, 6) whilst the inner cam 50 has corresponding outwardly projecting teeth 60, at the same angular pitch as the locking members 36, for camming the locking members 36 in and out by engagement with the cam-follower parts 42. Each inwardly projecting tooth 58 of cam 48 corresponds to one locking member 36 and has a sloping surface 62, a constant radius surface 64 and a radial surface 66 as shown. The cam-follower part 42 has an outer sloping surface 68 and outer constant radius surface 70 for engagement with the tooth 58, the sloping surfaces 62, 68 facing each other. The cam-follower part 42 has an inner sloping surface 72 and inner constant radius surface 74 for engagement with the corresponding tooth 60. When piston-in-cylinder units 76 (see below) are extended as shown in Fig. 5, the cams

48, 50 are rotated in the direction of arrow 77 so that inner teeth 60 of cam 50 slide on surfaces 72, 74 to move the ring of locking members 36 radially outwardly - the "unlocked" position. Conversely, when the piston-in-cylinder units 76 are retracted as shown in Fig. 6, the cams 48, 50 are rotated in the direction of arrow 79 so that outer teeth 58 of cam 48 slide on surfaces 68, 70 to move the ring of locking members 36 radially inwardly - the "locked" position.

Piston-in cylinder units 76

The connector 10 comprises four pairs of double-acting piston-in-cylinder units 76 (see above) around the ring-form cams 48, 50. Each piston-in-cylinder unit 76 comprises a cylinder 78 and piston 80.

The rear ends of the two cylinders 78 of each pair are pivotally connected to the supporting structure 14 by a removable vertical pivot pin 82 extending through lugs at the rear ends of the two cylinders and through holes in the base and top plates 20, 24. The top of each pivot pin 82 is covered by a cap-plate 84 removably bolted to the top plate 24, so that the pin 82 can be withdrawn after removal of the cap-plate 84.

The front ends of the two pistons 80 of each pair of

lugs 90, or "padeyes", on the outside of the ring-form cam 48. In one position of the ring-form cams 48, 50, the pivot pins 88 are covered by cap-plates 92 (only three cap plates 92 are shown in Fig. 2, one having been removed) removably bolted to the top-plate 26 (like cap-plates 84) for removal of pivot pins 88. Hence, removal and replacement of piston-in-cylinder units 76 is possible upon removal of cap-plates 84, 92 and pivot pins 82, 88.

Each piston-in-cylinder unit 76 is arranged to provide a larger effective piston surface area for unlocking than for locking, so that a greater torque is available to the ring-form cams 48, 50 for unlocking than for locking.

Seals

Seals which are subject to full fluid medium pressure are metal-to-metal seals. For example, there is a seal in the form of an annular metal gasket 93 in an annular space 94 within the bore 18, where the wellhead body 12 is sealed to the main body 16. A number of hydraulic seal retainers 96, arranged in a ring, are provided in the body 16 around the gasket 93, with hydraulic connectors 98, hydraulic units 100 and emergency manual release handles 102. There are also a number of test ports 104, arranged in a ring in the main

body 16, leading to an annular cavity 105 round the outside of the gasket 93, for testing the efficiency of the seal.

The top surface 106 of main body 16 has an annular groove 108 therein, surrounding the top opening 110 of bore 18, for a metal ring gasket (not shown) for sealing the connection of the connector 10 to the BOP stack (not shown).

There is a face seal 112 in a corresponding groove (not referenced) in a downwardly-facing annular surface 114 of main body 16, around the outsides of the rings of hydraulic seal retainers 96 and the test ports 104 where the latter enter the face 114.

Emergency Mechanical Override Mechanism 116

The connector 10 comprises an emergency mechanical override mechanism 116, which can be used to unlock the connector 10 in the event of loss of hydraulic power. The mechanism 116 cannot be used to lock the connector 10.

The mechanism 116 comprises a gearbox 118, omitted in Figs. 7 and 8, containing a first chain-gear 120, in the centre of which is a keyway 122, to receive a key (not shown) to be inserted by a diver (not shown) to

operate the mechanism 116. The gearbox 118 contains a second chain-gear 124, drivably connected by a chain 123 to the first chain-gear 120. (The chain-gears 120, 124 and chain 123 may be replaced by two inter-meshing gears 125, 127 as shown in Fig 9.) The second chain-gear 124 or gear 127 is fixed on a rotary shaft 126, on which there is also fixed a gearworm 128 which drivingly engages a toothed pinion 130. The pinion 130 is fixed on a rotary, screw-threaded shaft 132. An internally screw-threaded dog 134 is threaded on the shaft 132 and is slidably guided by fixed slides 136, 138 extending parallel to the shaft 132 and fixed by bolts 137, 139 to a fixed support 140, bolted by bolts 141, 143 to the bottom and top plates 20, 26 and forming part of the body structure 14. The dog 134 is abuttingly engageable, as shown in Fig. 7, with a lateral extension 142 of the outer ring-form cam 48, for rotating the two ring-form cams 48, 50 together in the requisite rotary direction for unlocking the connector 10.

To operate the mechanism 116, the diver (not shown) inserts the key (not shown) into the keyway 122 and rotates the gearwheel 120/gear 125 in the required direction. The gearwheel 120 drives the second gearwheel 124 (or gear 125 drives gear 127) and hence drives the gearworm 128, to rotate the shaft 132. This moves the dog 134 along the slides 136, 138 to rotate the cams 48, 50 in the direction for unlocking the

connector 10.

Visual Status Indicator 150

The connector 10 comprises a visual status indicator 150 (Fig. 1) comprising a vertical member 152 which is slidably guided in the top plate 26 and carries a roller 154 at its bottom end, riding on a cam 156 in the form of a ramp on the outer cam 48. When the piston-in-cylinder units 76 are retracted as shown in Fig. 1, the member 152 is also retracted. Conversely, when units 76 are extended, the roller 154 rides up the ramp 156 to extend the member 152. The member 152 is spring-loaded by a spring (not shown) to remain in engagement with the ramp 156.

The Wellhead Body 12

The wellhead body 12 (Fig. 4) has internal fittings indicated generally by reference 144. These are conventional and are not relevant to the present invention. Some distance below the very top end of the wellhead body 12 is an annular groove 146 which, in the locked state of connector 10, is engageable by the radially inner heads 40 of the locking members 36, to lock the connector 10 onto the wellhead body 12.

radially inner heads 40 of the locking members 36, to lock the connector 10 onto the wellhead body 12.

Normal Operation Of Connector 10

In normal operation, the connector 10 - already secured by bolts 34 to the BOP stack, not shown, see above - is lowered in the sea until the wellhead body 12 is received in the bore 18 and the inner heads 40 of locking members 36 (initially in their outer, unlocked, positions) are level with the groove 146 of the wellhead body 12. Then the piston-in-cylinder units 76 are hydraulically operated to rotate the cams 48, 50 and hence drive the locking members 36 radially inwardly until the heads 40 engage in the groove 146, thus locking the connector 10 to the wellhead body 12. If it is desired to unlock the BOP stack from the wellhead body 12, the piston-in-cylinder units 76 are hydraulically operated to rotate the cams 48, 50 in the opposite direction and hence drive the locking members 36 radially outwardly, hence disengaging the heads 40 from the groove 146.

Features Of Connector 10

1. Because the ring-form cams 48, 50 rotate about their own axis, their "swept volume" (that is, the total volume required to accomodate them and their movement)

is very little more than their actual volume.

2. Because the piston-in-cylinder units are around the outsides of the ring-form cams 48, 50, they are accomodated between the planes of the top and bottom surfaces of the main body 16, thereby avoiding any increase in the overall height of the connector 10, which is wide rather than high.

CLAIMS:-

1. A connector adapted for use undersea, comprising a plurality of locking members arranged in the form of a ring in a supporting structure, the locking members being radially movable inwards for locking the connector and outwards for unlocking the connector, at least one ring-form cam co-axial with the ring of locking members and rotatable about its axis for positively moving the locking members radially inwards and outwards for locking and unlocking the connector, and hydraulic motor means connected between the supporting structure and the at least one ring-form cam for rotating the or each ring-form cam selectively in one rotary direction or the opposite rotary direction.

2. A connector as claimed in claim 1 wherein each locking member has a head at a radially inner end thereof and a cam follower-part, engageable with the at least one ring-form cam, at a radially outer end thereof.

3. A connector as claimed in claim 1 or 2 wherein said at least one ring-form cam is a unitary structure rotatable in one direction for locking the connector and in the opposite direction for unlocking the connector.

4. A connector as claimed in claim 3 wherein the unitary structure is in two parts, one part being a first ring-form cam for positively moving the locking members radially inwards and the other part being a ring-form cam for positively moving the locking members radially outwardly, the two parts being separately made and connected together to form the unitary structure.

5. A connector as claimed in any preceding claim wherein the hydraulic motor means comprises at least one double-acting piston-in-cylinder unit.

6. A connector as claimed in claim 5 wherein the or each piston-in-cylinder unit is arranged to provide a larger effective piston surface area for unlocking than for locking, so that a greater torque is available to the at least one ring-form cam for unlocking than for locking.

7. A connector as claimed in claim 5 or 6 wherein said at least one piston-in-cylinder unit is/are connected to the supporting structure and to the at least one ring-form cam by pivot pins which are removable so as to permit removal and replacement of said at least one piston-in-cylinder unit.

8. A connector as claimed in any preceding claim wherein the supporting structure comprises a body.

9. A connector as claimed in claim 8, said body having individual radial guides for the locking members.

10. A connector as claimed in claim 9 wherein said radial guides are radial passages through said body.

11. A connector as claimed in claim 8, 9 or 10 wherein said body has a passage therethrough for oil to flow through and has mounted thereto a top plate and a base plate.